AUSTRALIAN CUMACEA
No. 18

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NOTES ON DISTRIBUTION AND NIGHT COLLECTING WITH ARTIFICIAL LIGHT

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Fig. 1-3

SUMMARY

The paper describes an experiment in collecting Cumacea at Garden Island, Western Australia. An electric globe of low candle-power, attached in the centre of the mouth of a tow-net, was lowered to the bottom, on the same spot, at regularly spaced time intervals, throughout one night, and remained immersed before each haul for 15 minutes. The peak period for the congregation of Cumacea at the lamp occurred at 2 a.m.; the results are discussed in some detail.

The distribution of Australian Cumacea is also recorded.

INTRODUCTION

One hundred and sixty species of Cumacea are now recorded from shallow waters off the west, south and east coasts of Australia; very little is known of the Cumacea of the north coast.

Fig. 1 shows the specific representation of three families; the greatest number of species (sixty) is found in the Bodotriidae. The Leuconiidae and Lampropidae, with three and two Australian species respectively (four from the east coast and one from the south) are not included.

The diagram, of course, is in no way a quantitative index. It appears certain that individually the Bodotriids are predominant and that of the three families the Diastylidae play a relatively minor part.

In number of species the Bodotriids outstrip each of the other two families on the Indian Ocean and southern Australian coasts, but on the Pacific side the Diastylids are equally well represented, largely because of the numerous small forms referred to *Gynodiastylis* and allied genera.

On the evidence of material collected to date, the greatest speciation in all families has occurred on the Pacific Coast, particularly in the areas near rivers, while the south coast has produced the fewest species; it is to be borne in mind, however, that the large southern stretch of the Great Australian Bight has not been investigated for Cumacea, although it seems unlikely that many additional records will result from shallow-water collecting there.

NIGHT COLLECTING WITH UNDERWATER LIGHT

It is known that Cumacea are attracted by artificial light at night (Fage, 1933, 1945, etc.; Foxon, 1936, p. 378; Hale, 1943, p. 337). The use of a submerged light during the hours of darkness has proved a useful method of collecting these crustaceans, other marine invertebrates and fishes (Fage, 1927, p. 25, 1933, p. 107, etc.; Sheard, 1941, p. 12). It should be emphasised that in our experience use of a lamp of low candle power (about 2·5) results in more effective catches of Cumacea than does employment of a brilliant light. Gilbert

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C. Klingel, in his book "Inagua" (London, 1942, p. 297), states that, working in Chesapeake Bay, he prepared a 5,000-watt assembly, with which he hoped to attract a vast assortment of marine life to his observation post. He found that while his installation improved visibility, little came to its beam, so he resumed his "old method of using flashlights, which was much more satisfactory."

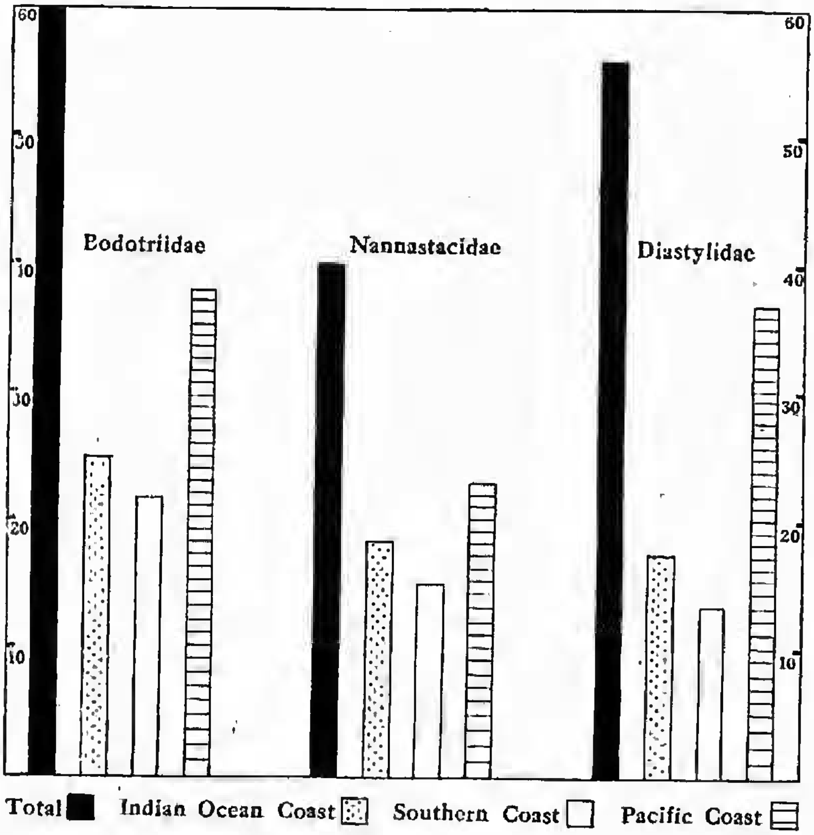

Fig. 1
Distribution of Australian Cumacea; the columns represent numbers of species.

Of the Australian littoral species of Cumacca, 19 per cent. have been secured by submarine light traps and by no other method. Some time ago doubts arose as to whether this means of obtaining material provided a true representation, as selectivity, time of operation, tides and other factors might operate. One may state at once, however, that 37 per cent. of the species taken by trawl and dredge have been attracted to lights also, so that nearly half of the Australian species collected to date are known to respond, and this notwithstanding the fact that underwater lights have not been very long utilized for obtaining Cumacea in Australian waters, nor have they been used in all areas investigated there.

As a result of our discussions, Dr. A. G. Nicholls, with the assistance of some of his students in the Biology Department of the University of Western Australia, undertook a regular series of submarine light hauls throughout a single night. The experiment was conducted on 26-27 November, 1946; a tow-net, with a lamp of low candle-power hung in the mouth as described by Sheard (1941, p. 13), at each hour from 6 p.m. to 6 a.m., was lowered to the sandy bottom and left undisturbed for fifteen minutes. The net was operated from a jetty at Careening Bay, Garden Island, Western Australia, in three fathoms of water; the small tidal rise or fall on this part of the Australian coast (two to three feet) is considerably modified by on-shore and off-shore winds. The net was placed in exactly the same spot for each haul, as far as was practicable under working conditions.

On the night of the experiment the moon was in its first quarter—the new moon occurring on 24 November at 1.24 a.m., and first quarter on 2 December at 5.47 a.m., Western Australian standard time. Sunset occurred at 7.5 p.m. on 26 November and sunrise at 5.6 a.m. on the following day. There was a clear sky until the early hours of the morning of 27 November, when light clouds appeared. The night commenced with a strong easterly breeze, which died down later, and Dr. Nicholls noted that so much detritus was raised from the bottom by violent wave action that the range of the light was materially affected; on the other hand this factor may have been responsible for disturbing a greater number of burrowing animals than would have obtained otherwise.

High tide slack occurred between 6 p.m. and 7 p.m., but this period was increased by the easterly breeze which tended to bank up the water in the bay. The tidal run-off was retarded and the tide was not ebbing strongly until about 8 p.m. The first period of ebb was completed by 10 p.m. and then followed a long period of slack mid-water until about 3 a.m., when the ebb was completed. Low tide was at about 5.6 a.m. and the tidal range was two feet nine inches.

No Cumacea were present in the net after fifteen minutes immersion during sunset and again three-quarters of an hour later, and were absent also in two nettings made during sunrise and an hour after. In so far as Cumacea are concerned effective catches occurred only between 8 p.m. and 4.15 a.m., when nine hauls produced more than five thousand Cumaceans, representing twelve genera of three families—as well, of course, as a great many other Crustacea and other invertebrates.

The writer is greatly indebted to Dr. Nicholls, who later separated all Cumacea from the mass of material in each catch. The writer then sorted out the various species; several new forms were represented and have been described (Hale, 1948, 1949 and 1951). The twenty-seven species secured are as follows:

Family BODOTRIIDAE

Cyclaspis pura Hale
Cyclaspis juxta Hale
Cyclaspis nitida Hale
Cyclaspis sheardi Hale
Cyclaspis mollis Hale
Cyclaspis mjobergi Zimmer
Cyclaspis fulgida Hale
Eocuma agrion Zimmer
Vaunthompsonia nana Hale
Leptocuma nichollsi Hale
Glyphocuma serventyi Hale
Gephyrocuma repanda Hale

Family NANNASTACIDAE

Nannastacus inflatus Hale
Nannastacus subinflatus Hale
Nannastacus inconstans Hale
Nannastacus clavatus Hale
Nannastacus nichollsi Hale
Nannastacus vietus Hale
Cumella similis Fage
Cumella cana Hale
Schizotrema aculeata Hale
Schizotrema leopardina Hale
Schizotrema resima Hale

Family DIASTYLIDAE

Dimorphostylis cottoni (Hale)
Anchistylis waitei (Hale)
Gynodiastylis turgida Hale
Gynodiastylis inepta Hale

Dimorphostylis vieta Hale is the only species not listed above which has been taken in other collections made at Garden Island, and this is represented by a single female (G. P. Whitley, submarine light, 19 July 1945).

The hourly catches of Cumacea secured during this night collecting experiment are shown in fig. 2. Only about one hundred individual Diastylids were taken; this number is too small to be of much significance, but nevertheless the incidence of members of the family shows a gradual increase from 10 p.m. until the 2 a.m. haul, at which approximately half the total specimens of Diastylidae were secured.

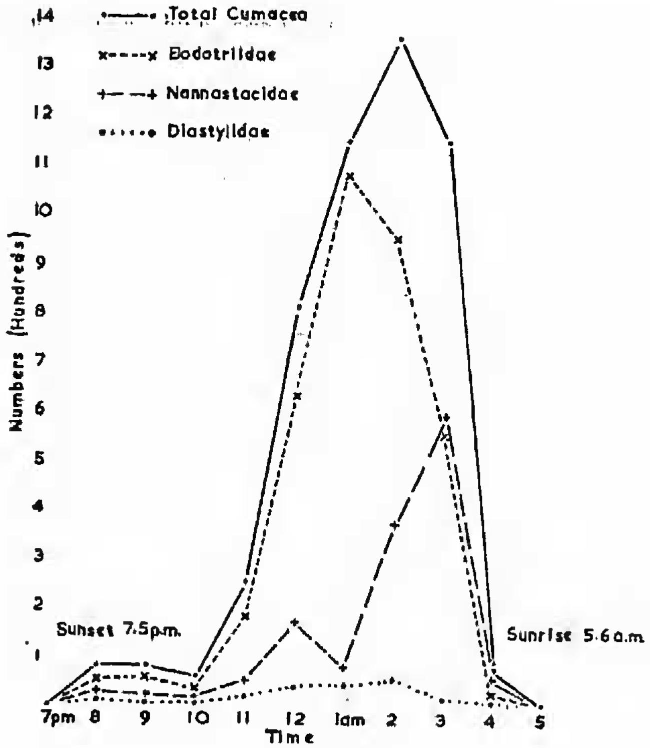

Fig. 2

Periodic variation in abundance of Cumacea attracted to underwater light at night.

The most productive nettings occurred between 11 p.m. and 3.15 a.m. The proportions of the most abundant species are:—

Cyclaspis pura Hale - - - -	69·7 per cent.
Other Bodotriids - - - -	1·8 ,, ,,
Nannastacus subinflatus Hale - - -	5·3 ,, ,,
Nannastacus inconstans Hale - - -	8·8 ,, ,,
Schizotrema leopardina Hale - - -	7·1 ,, ,,
Other Nannastacids - - - -	5·2 ,, ,,
Diastylids - - - - -	2·1 ,, ,,

Cyclaspis pura, represented mainly by adult males, is dominant in *all* hauls made before 3 a.m., and as 97·5 per cent. of the Bodotriids are referable to this species the remaining members of the family made no appreciable difference to the graph for the family.

The Nannastacids, almost all of which are males, became prominent in the takings much later than *Cyclaspis.* The three species noted above, each represented by not less than 270 examples, together constitute 80·5 per cent. of the total for the family. At midnight Nannastacids were plentiful (fig. 2), but by 1 a.m. the two most abundant species of *Nannastacus* showed a marked decrease (fig. 3). The *Cyclaspis pura* males were then increasing and coincident with the sudden falling off of this species at 2 a.m. and 3 a.m. the *Nannastacids* increased in number, reaching their peak occurrence at 3 a.m. (at which time they slightly outstripped the Bodotriids), declining in the next haul, one hour before sunrise, almost to vanishing point (cf. Fage, 1945, p. 174). The considerably increased representation of this family at 2 p.m. resulted in the peak Cumacean catch at that hour, when 945 Bodotriids and 380 Nannastacids were netted.

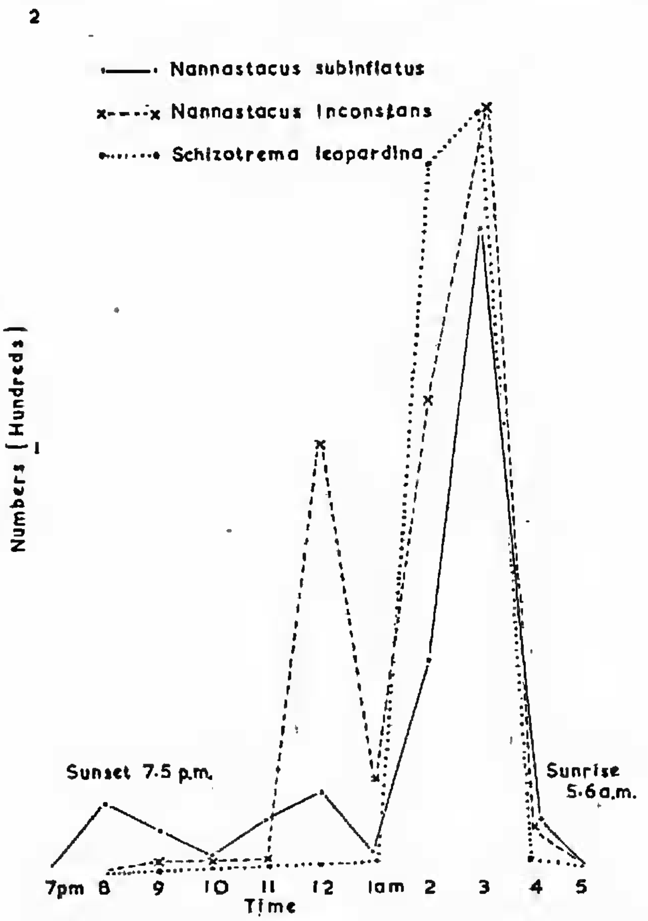

Fig. 3
Periodic variation in abundance of Nannastacids attracted to underwater light.

DISCUSSION

At the moment one has no means of judging whether or not the results of this fishing on the bottom furnish a real indication of the nocturnal activity of the Cumacea concerned; the following criticisms may be considered:—

(1) The possibility that all Cumacea found in the net had been stimulated by the light and that normally all would have remained quiescent.

Against this we have the well-known fact that shallow water Cumacea migrate to the surface during hours of darkness.

(2) It might be suggested that the catches consist partly of Cumacea which at the time of taking were normally active (*viz.*, in the initial stages of their

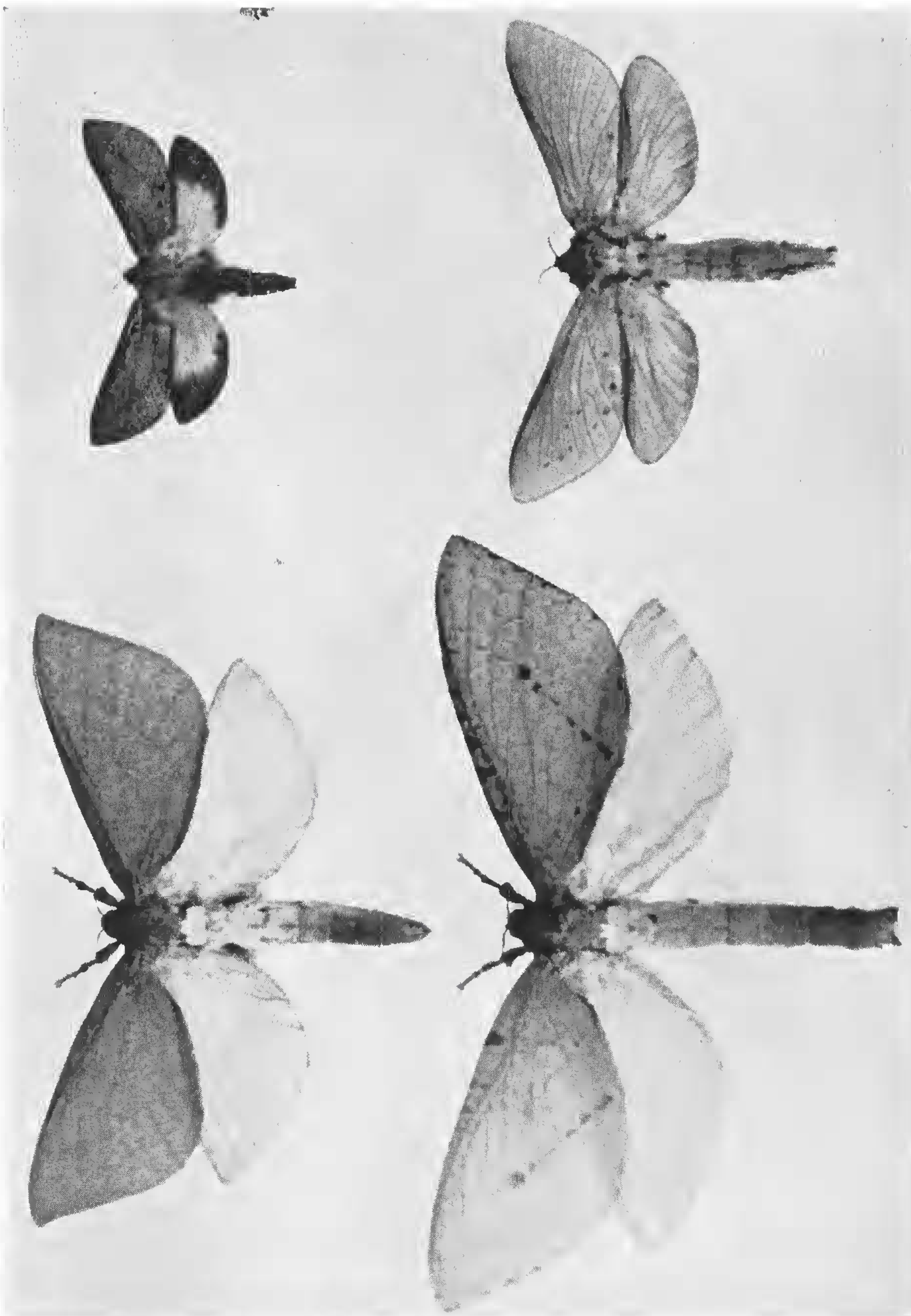

Fig. 1-2 *Oenetus scotti*
Upper left, male
Lower left, female

Fig. 3-4 *Oenetus paradiseus*
Upper right, male
Lower right, female

nocturnal vertical migration) and partly of individuals stimulated to activity by the light.

This theory could be employed to account for the marked preponderance of some forms throughout the series. Bodotriids predominate in the Garden Island collections; this family, however, is much more richly represented in the Indian and Pacific Oceans than it is in the Atlantic, and in Australian waters *Cyclaspis* in particular occurs almost everywhere where there is a sandy bottom. On the other hand *Anchistylis* and *Dimorphostylis*, sparsely represented at Garden Island on the night of collecting, have come to bottom lights in other Australian localities in abundance, and then may have been attracted during periods of normal night migrations.

(3) One must consider the possibility that an underwater light is a selective factor in that (a) some of the species more sparsely represented in the collections may be those which do not readily respond to light, or which may not be such active swimmers as the others; (b) males respond to the stimulus of light more readily than females.

For and against (a) is the fact that Cumacea which are relatively poor swimmers and are not normally active in great numbers (adult females of *Cyclaspis*, Hale, 1944, pp. 122 and 124), may be attracted on some nights to an underwater light of low candle-power in myriads, and that *Gynodiastylis* and allied genera have not been taken in quantity by any method—tow-net, Agassiz trawl or submarine light.

(b) As already noted, adult males far outnumber females and sub-adults in the material now under discussion and comprise about 90 per cent. of the individuals taken. Fage states that in the material examined by him the number of females collected at night without aid of a light is greater in proportion to that of males than when a light was employed. He suggests that the sexes may unite either below or to the side of the zone illuminated by the light. On the other hand one may mention *Cyclaspis sheardi*, a species widely distributed in southern Australia, ranging from lat. 34·0 S on the east coast to lat. 21·0 S on the west coast; the various methods of collecting used have, with one exception, resulted in the capture of adult males—many hundreds of them. One ovigerous female provided the exception and this was taken by underwater light. Again, as previously noted, there are indications that in at least one species of *Cyclaspis* the adult female, with soft exoskeleton, becomes active in considerable numbers at night and then may be attracted to artificial light near the bottom (Hale, 1944, p. 124). In *Nannastacus, Schizotrema*, and *Cumella*, males are much more commonly taken than are females in tow-net or dredge. Males usually predominate in submarine light collections of some Australian Diastylids, notably *Anchistylis* and *Dimorphostylis cottoni* (Hale), but on occasion recently moulted adult females are very much more abundant than males (Hale, 1945, p. 208). Females with ova in the marsupium far outnumbered males in a large number of specimens of *Anchistylis waitei* Hale which came to a submerged light at West Wallabi Island, Houtman Abrolhos group, Western Australia (G. P. Whitley, 9·40-10·40 p.m., 2 fath., Dec. 1945).

(4) One final criticism presents itself, namely, that at Garden Island the stimulus of the artificial light may have had a cumulative effect, and that the peak takings represent the maximum concentration of Cumacea which had slowly made their way from the periphery of the area influenced by the light (see Foxon 1936, and Hale 1943). In other words, that the sudden decrease in numbers in the early hours of the morning means merely that the area had been "fished out" as far as Cumacea are concerned.

This would seem to be supported by the fact that the Nannastacids appeared in quantity later than the male Bodotriids, and began to decrease in number later